OPTIMATION, INC.

PRECISION
POWER OSCILLATOR
MODEL AC-15 AND AC-15B

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MODEL AC-15 AND AC-15B

PRECISION
POWER OSCILLATOR

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DIFFERENCE DATA SHEET

MODEL AC-15B 15VA AC POWER SOURCE

1-1. SCOPE.

1-2. This difference data sheet covers the Optimation, Inc. Model AC-15 and AC-15B AC Power Source and describes the differences to the Model AC-50 manual enclosed.

1-3. DESCRIPTION.

1-4. The Model AC-15 is identical in performance and operation to the Model AC-50 described in this instruction manual with the following exceptions:

1. OUTPUT POWER is 15VA rms, ±10%, 0.1 to 20,000 Hertz. Down -20% at 0.1 Hertz. The Model AC-50 as described herein has a mid-band power output of 50VA.

2. FREQUENCY INSTABILITY is less than 100ppm/hour at a constant temperature. The Model AC-50 has a frequency instability of less than 0.02%/hour.

3. POWER CONSUMPTION is 60VA at rated output power. The Model AC-50 is 120VA.

1-5. OPERATIONAL DIFFERENCES.

1-6. The front and rear panel operating controls of the Model AC-15 are identical to the AC-50 as described herein except for the following:

1. OVERLOAD. The Model AC-15 has a front panel OVERLOAD indicator which illuminates when the output is overloaded or shorted. Reset is automatic when the overload or short is removed.

1-7. CIRCUIT DIFFERENCES.

1-8. The AC-15 is identical to the AC-50 with the exception of the power output stage and overload circuitry as described on pages 4-8 and 4-9.

1. The AC-15 uses two power output transistors connected for push-pull operation where the AC-50 uses 4.

2. Fuse protection of the output transistors in the AC-50 is replaced by current limiting protection with lamps DS101 and DS103 in the AC-15.

3. Overload transistors Q112 and Q113 and overload relay K1 in the AC-50 have been eliminated in the AC-15. Overload indication in the AC-15 is provided by lamps DS105 and DS106 and reset is automatic when the overload or short is removed.

CAUTION

If the OVERLOAD indicator lights remove the overload or short IMMEDIATELY or set the POWER switch to OFF. Damage to the AC-15 may result if the overload is not removed.

1-9. The electrical parts listing and schematic appended to the AC-50 manual cover the Model AC-15.

AC15 AND AC-15B SPECIFICATIONS.

FREQUENCY (AC-15)

Range	0.1 Hertz to 99,900 Hertz in four decade ranges.
Resolution	3 most significant digits and a vernier control.
Accuracy	±1.0% of setting.
Instability	Less than 100ppm/hour at a constant temperature.

FREQUENCY (AC-15B)

Range	0.1 Hertz to 99,990 Hertz in four decade ranges.
Resolution	4 most significant digits and a vernier control.
Accuracy	±0.1% of setting, 10 to 9,999 Hertz. Decreases to ±0.3% at 90,000 Hertz.
Instability	Less than 100ppm/hour at a constant temperature.

PURITY

Harmonic Distortion	Less than 0.05% from 90 to 10,000 Hertz.
Hum and Noise	Less than 100ppm of rated output.
Modulation	Less than 0.1% near line frequency.

OUTPUT

Power	15VA rms, ±10%, 0.1 to 20,000 Hertz. Down -20% at 0.1 Hertz.
Voltage	0 to 15 volts rms, open circuit. 11 volts rms into a matched load impedance of 8 ohms.
Impedance	Front panel load regulation control sets the effective impedance to zero.
Coupling	DC coupled output.
Configuration	Isolated from ground (floating) or grounded output configuration.

AMPLITUDE

Instability, short term	100ppm maximum, to 20,000 Hertz.
Attenuation	11 position step attenuator with interpolating vernier potentiometer.

POWER REQUIREMENTS

Line Voltage	115 volts AC, or 230 volts AC, ±10%, switch selectable, 1Ø.
Line Frequency	50 to 400 Hertz.
Power Consumption	60VA.

MECHANICAL REQUIREMENTS

Dimensions:	
Rack Mounting	3½"H, 19"W, 16"D.
Bench Mounting	3½"H, 17"W, 16"D.
Weight	33 pounds, net.

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SECTION I

GENERAL INFORMATION

1-1. SCOPE.

1-2. This publication covers the standard Optimation, Inc. Model AC-50 and AC-50B Precision AC Calibration Source. Optional differences which may be contained in the Calibration Source are noted on difference data sheet(s) at the front of this manual.

1-3. GENERAL DESCRIPTION.

1-4. AC-50 DESCRIPTION. The Model AC-50 is a Precision AC Calibration Source with a midband power output of 50VA from 0.1 to 20,000 Hertz. Short term amplitude stability of better than 100ppm and output amplitude of 15 volts rms makes it ideally suited to a wide range of laboratory calibration applications.

1-5. Output frequency of the AC-50 is digitally dialed-in over the frequency range of 0.1 to 99,900 Hertz. The accuracy of the setting is better than 1.0% above 10 Hertz with a resolution of three digits. A floating decimal point is provided so that the front panel setting is always read directly in Hertz and does not require interpolation by the operator. Output voltage is set with an 11 position step attenuator and a high resolution (0.01%) interpolating vernier control. Output impedance (load regulation) of the output amplifier stage can be adjusted to zero with a recessed front panel adjustment potentiometer. This is particularly important when calibrating precision AC instruments which have an input impedance that varies as a function of voltage.

1-6. AC-50B DESCRIPTION. When optional feature B, Accurate Frequency, is included in the standard Model AC-50 an additional frequency selector switch is provided to improve the setting accuracy to better than ±0.1% over the range of 10 to 9,999 Hertz. Setting accuracy decreases to about 3.0% at 0.1 Hertz and 0.3% at 90,000 Hertz.

1-7. Some of the more significant operating features of the Model AC-50 are:

1. Wide output frequency range of 0.1 to 99,900 Hertz. Down to 10 Hertz with option T or T-500.

2. Accurate output frequency of 1.0% (AC-50) or ±0.1% (AC-50B).

3. Low distortion of less than 0.05% from 90 to 10,000 Hertz at rated output power.

4. Output power of 50VA, ±10%, over the frequency range of 0.1 to 20,000 Hertz. With option T, output power is 45VA over the range of 45 to 20,000 Hertz.

5. Short term amplitude instability of less than 100ppm to 20,000 Hertz.

6. Optional output transformer extends voltage range to 150 volts rms over the frequency range of 45 to 20,000 Hertz.

1-8. SPECIFICATIONS.

1-9. The Model AC-50 is designed for continuous operation in a normal laboratory environment over the ambient temperature range of 0°C to 55°C. Within this range, the AC Calibration Source will operate with the performance and accuracy specified in table 1-1. Warm up time for the given accuracies is 1½ hours.

1-10. OPTIONAL FEATURES.

1-11. The Model AC-50 may contain one or more of the optional features which are described below. A serial number label affixed to the rear panel identifies the option(s), if any, which are contained in the AC Calibration Source. For example, the Model AC-50BDS includes options B, D and S. Operational differences in the instrument which are affected by these features are described by the difference data sheets.

1. Option C, STABLE FREQUENCY. Frequency instability is held to less than 10ppm at a constant temperature. Temperature coefficient is less than 30ppm/°C from 10 to 9,999 Hertz. Option B must be inluded with option C (AC-50B only).

2. Option D, HIGH RESOLUTION FREQUENCY VERNIER. Optional frequency vernier potentiometer provides high resolution frequency setability. Maximum frequency change is 0.25% of setting. Option B must be included with option D (AC-50B only).

3. Option G, EXTERNAL FREQUENCY SYNC. A rear panel input connector is provided for syncing the AC-50 to an external signal. Oscillator will frequency lock to the external signal over the wide

range of ±0.5% of setting.

4. Option H, HIGH RESOLUTION AMPLITUDE CONTROL. Consists of a three-stage vernier potentiometer and 11 position coarse step attenuator to provide a resolution of less than 3ppm full scale. Short term amplitude stability is better than 20ppm with option H.

5. Option S, SQUARE WAVE OUTPUT. In addition to the sine wave output, provides a 0 to 27 volts p-p square wave output (switch selectable). Rise time is better than 0.1% of the period or 100 nanoseconds.

1-12. PREPARATION FOR RESHIPMENT.

1-13. Electronic calibration equipment and test instruments must be packed with special care. The shipping carton in which the instrument was originally packed is designed to provide maximum protection from adverse environments and from the shock and vibration incurred during shipment. It should be preserved and utilized for reshipment or subsequent storage whenever possible. When preparing the instrument for reshipment, ensure that the container is well sealed with strong tape or metal bands.

TABLE 1-1. SPECIFICATIONS.

FREQUENCY (AC-50)	
Range	0.1 Hertz to 99,900 Hertz in four decade ranges.
Resolution	3 most significant digits and a vernier control.
Accuracy	±1.0% of setting from 10 to 99,900 Hertz. ±3.0% at 0.1 Hertz.
Instability	Less than 0.02%/hour at a constant temperature.

FREQUENCY (AC50B)	
Range	0.01 Hertz to 99,990 Hertz in four decade ranges.
Resolution	4 most significant digits and a vernier control.
Accuracy	±0.1% of setting from 10 to 9,999 Hertz. ±3.0% at 0.1 Hertz and ±0.3% at 90 kilohertz.
Instability	Less than 0.02%/hour at a constant temperature.

PURITY	
Harmonic Distortion	Less than 0.05% from 90 to 10,000 Hertz.
Hum and Noise	Less than 100ppm of rated output.
Modulation	Less than 0.1% near line frequency.

OUTPUT	
Power	50VA rms, ±10%, 0.1 to 20,000 Hertz. Down 3db at 100kHz.
Voltage	0 to 15 volts rms, open circuit.
Impedance	Load regulation adjustment sets the effective impedance to zero.
Coupling	DC coupled output.
Configuration	Isolated (floating) or grounded.

TABLE 1-1. SPECIFICATIONS (continued)

AMPLITUDE

Instability, Short Term	100 ppm maximum, to 20,000 Hertz.
Attenuation	11 position step attenuator with interpolating vernier potentiometer

POWER REQUIREMENTS

Line Voltage	115 volts AC, or 230 volts AC, ±10% switch selectable, 1Ø.
Line Frequency	50 to 400 Hertz.
Power Consumption	120VA

MECHANICAL REQUIREMENTS

Dimensions:	
Rack Mounting	3½"H x 19"W x 16"D.
Bench Mounting	3½"H x 17"W x 16"D.
Weight	

SECTION II

INSTALLATION

2-1. UNPACKING AND HANDLING.

2-2. The AC-50 is shipped in a single packing container. All of the accessories which are supplied are packed in the same container. Handle the instrument carefully when removing it from the shipping container, using caution not to damage any of the front panel operating controls or rear panel heatsink assemblies.

2-3. POWER REQUIREMENTS.

2-4. The AC-50 is designed to operate from 115 volts, ±10%, or 230 volts, ±10%, single-phase AC, at a line frequency of 50 to 400 Hertz. The AC LINE selector switch located on the rear panel converts the instrument from one operating voltage to the other. To convert the AC-50 from 115 volts to 230 volts, move the slide switch to the 230 volts position and change fuse F1 to 0.5 amps, slo-blo.

2-5. INITIAL INSPECTION.

2-6. VISUAL INSPECTION. Inspect the AC-50 after unpacking for damage that may have occurred during transit. Check that there are no loose or broken knobs, bent or broken panel connectors, and dents or scratches on the cabinet surfaces. Specifically, the instrument should be visually inspected for the following items before placing it into operation.

1. Check that the front panel frequency selector switches can be rotated freely and without binding through the 10 detent positions.

2. Check that the rear panel AC LINE selector switch is set to 115 volts unless the instrument is to be operated from a 230 volt AC line source.

3. Remove the bottom cover by removing the flat head screws.

4. Check that all socket mounted components, such as transistors

and potentiometers, are firmly seated into the sockets.

5. Check that the lamps are not damaged or broken and are properly seated in the sockets.

6. Check that vacuum tube V1 is properly seated and not damaged or broken.

7. Check for any loose or damaged components.

8. Replace the bottom cover and flat head screws.

NOTE

If the instrument was damaged during shipment it must be reported immediately to the responsible carrier. A complete report of the damage must be submitted to the carrier's claim agent with a copy forwarded to Optimation, Inc. Unless this damage claim is properly filed, Optimation cannot be held responsible for any subsequent repair or replacement charges.

2-7. INSTALLATION REQUIREMENTS.

2-8. GENERAL. The AC-50 does not require any special installation procedures or cooling requirements. Two different mounting cabinets are available and are described below.

2-9. CABINET MOUNTING. The standard instrument is supplied in a cabinet which is suitable for either bench or portable use. A convenient combination handle and tilt stand can be used to carry the instrument and then when locked in the lower detent position provides an easy viewing angle of the front panel for bench operation. Four plastic feet are mounted on the bottom to protect the cover from scratches.

2-10. RACK MOUNTING. When optional feature R is supplied, the instrument is mounted in a rack mounting cabinet. It can be installed in any EIA standard 19 inch wide cabinet that has 3½ inches of panel mounting space available with the four rack mounting screws supplied. Care must be taken to allow a minimum of 6 inches of clear space behind the instrument and at least 3 inches of clear space at both sides to permit the proper circulation of air. The instrument is cooled by normal convection and does not require any additional cooling when operated within the operating temperature range.

2-11. CABLE ASSEMBLIES.

2-12. AC POWER CABLE. A separate 3-conductor power cord is supplied with the instrument which connects to the rear panel AC LINE receptacle. For the protection of operating personnel the front panel and cabinet surfaces are connected to the ground pin of the AC LINE receptacle. If the instrument is connected to a 2 pin non-polarized electrical outlet a 2 prong adapter must be used with the pigtail wire of the adapter connected to an adequate electrical ground.

2-13. OUTPUT LEADS. The front panel output terminals will accept a GR type of banana plug, spade connectors or tinned leads. Output terminals are provided on both the front and rear panels. The internal impedance of the AC-50 can be adjusted through zero (load regulation) and at most output amplitude levels the length and type of leads used is not critical. However, if the instrument is to be used as a source of low signal levels it is recommended that the output leads be shielded.

2-14. INITIAL OPERATION AND CALIBRATION.

2-15. INITIAL TURN ON. Connect the AC line cord between the rear panel AC LINE receptacle and a suitable power source. Set the OUTPUT LEVEL controls to minimum. Set the POWER switch to ON. Check that each of the FREQUENCY IN CYCLES PER SECOND digit windows light and that one of the decimal points light. Rotate the DECADE switch through each detent position and check that a decimal point lights for each setting. The Model AC-50 is now ready for operation.

2-16. INITIAL CALIBRATION. All internal adjustments have been made at the factory and the AC-50 is calibrated with laboratory standards which are traceable to the National Bureau of Standards. The instrument is ready for use when received.

SECTION III

OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. The Model AC-50 is a precision source of AC voltage which can be used in a wide range of applications. To make the most effective use of the instrument, the operation of all controls and the performance capabilities must be known. This section describes the operation of the controls and connectors and contains general operating information.

3-3. OPTIONAL FEATURES. Optional features which affect the operation of standard controls and connectors may also be included in the instrument. The difference data sheets at the front of this manual describes these features if contained in the AC-50.

3-4. OPERATING TEMPERATURE.

3-5. The Model AC-50 can be operated where the ambient air temperature is between 0°C and 55°C. It can be stored in temperatures that are between -25°C and 75°C. After storage at temperatures that are beyond the normal operating limits allow the instrument to reach the operating temperature range before applying power to prevent moisture condensation.

3-6. OPERATING CONTROLS AND CONNECTORS.

3-7. GENERAL. A brief description of the function and operation of each operating control and connector for the AC-50 and AC-50B follows. Detailed operating instructions are given in paragraphs 3-10 and 3-14.

3-8. AC-50 FRONT PANEL.

1. FREQUENCY IN CYCLES PER SECOND.- Selector switches which set the 3 most significant digits (left-hand) of the output frequency. The digit indicators display the selected frequency with

the two least significant digits (right-hand) fixed at zero so that the frequency setting is always read directly in Hertz. The four most significant digits of frequency can be selected on the AC-50B with only the least significant digit fixed at zero.

2. DECADE.- Selects the decade frequency range and positions the floating decimal point. Four decade ranges are provided.

3. VERNIER.- Adjusts the output frequency over a vernier range of approximately 1.5% (0.15% on AC-50B) of the setting. Output frequency is calibrated to the front panel setting when the VERNIER control is set to the CAL position.

4. POWER.- Controls power to the instrument. Frequency digit indicators and one decimal lamp will light when set to ON.

5. LOAD REGULATION. Recessed screwdriver adjustment to set the effective load regulation (output impedance) to zero.

6. OVERLOAD.- Lighted pushbutton which indicates the output is overloaded or shorted. Must be pushed and held for approximately two seconds to reset the overload circuit after the short or overload has been removed.

7. OUTPUT LEVEL.- Step and vernier attenuators. The STEP attenuator is calibrated in approximate 10% steps. The VERNIER attenuator provides continuous attenuation of the output amplitude between the fixed steps. Resolution is approximately 100ppm of full scale.

8. GND.- Chassis ground terminal.

3-9. AC-50 REAR PANEL.

1 1. OUTPUT.- Floating output connectors for the AC-50 output signal.

2. DC BALANCE.- Screwdriver adjustments for setting the DC component (offset) of the output signal to zero volt.

a. AMP.- Sets the DC balance of the Power Amplifier stage.

b. OSC.- Sets the DC balance of the Oscillator stage.

c. TEST.- Test points for the DC balance adjustments.

3. BIAS.- Screwdriver adjustment for setting quiescent collector current of the output transistors.

a. PRESS TO TEST.- Pushbutton which connects the test points in series with the collector circuits of the output transistors.

b. ADJ.- Sets the quiescent collector current.

4. 10Hz (AC-50B only).- Calibrates the output frequency on the 10 to 100Hz decade range.

5. 100Hz (AC-50B only).- Calibrates the output frequency on the 100Hz to 1kHz decade range.

6. 1000Hz (AC-50B only).- Calibrates the output frequency on the 1 to 10kHz decade range.

7. 10000Hz (AC-50B only).- Calibrates the output frequency on the 10 to 100kHz decade range.

3-10. PRELIMINARY OPERATION.

3-11. GENERAL. The Model AC-50 does not require any special preliminary operating procedures. The following paragraphs are only intended as a guide for operator familiarization with the operation of the instrument.

3-12. INITIAL TURN ON. The following steps outline the general procedure when initially applying power to the instrument.

1. Check the rear panel switch and determine that it is set to the correct position (115 or 230 volts) for the power source that is to be used.

2. Set the OUTPUT LEVEL controls to minimum (fully counterclockwise).

3. Set the POWER switch to ON.

NOTE

Due to line transients the OVERLOAD indicator may light when power is initially applied to the instrument. If it does, depress the OVERLOAD pushbutton and hold for approximately two seconds to reset the overload circuit.

4. The AC-50 is now ready for operation. To meet the specifications listed in table 1-1 a 1½ hour warm up period must be allowed after the instrument is initially turned on. If operation is attempted without sufficient warm up the output amplitude and frequency may slowly drift and exceed the given specifications.

NOTE

A time delay circuit interrupts the interconnection between the oscillator and power amplifier stages

for approximately 45 seconds after power is initially applied. An output signal will not be present during this interval. This allows the circuits to stabilize and prevent possible damage to the output amplifier due to an excessive signal.

3-13. OPERATION. The steps below demonstrate the correct procedure to be followed when setting the front panel controls for typical applications. Paragraph 3-14 gives detailed operating instructions for each control and connector.

1. Set the STEP and VERNIER controls to minimum (fully counterclockwise).

2. Set the frequency and DECADE switches to the desired output frequency. Frequency is read directly in Hertz with the decimal point automatically positioned.

3. Set the VERNIER control to the CAL position.

4. Connect the OUTPUT terminals for a grounded or floating output configuration. Refer to paragraph 3-30.

5. Connect the load to be driven to the output terminals.

6. Adjust the STEP and VERNIER attenuators for the desired output voltage.

7. Adjust the LOAD REGULATION if desired. Refer to paragraph 3-26.

CAUTION

If the OVERLOAD lamp lights this indicates that the output is overloaded or shorted. Should this occur, disconnect the load immediately and check the output leads for proper connection and/or shorts. Also make sure that the load impedance and ouput voltage combination does not exceed the output power rating of the AC-50.

3-14. GENERAL OPERATING INFORMATION.

3-15. OUTPUT FREQUENCY. The output frequency of the AC-50 can be set accurately using the front panel operating controls which eliminates the need for external frequency monitoring instruments for most applications. The three most significant digits (four digits on AC-50B) of frequency are set by the frequency selector switches and the range is set by the DECADE switch. The VERNIER control varies the frequency over a narrow high resolution vernier range

for setting the frequency with an accuracy greater than can be obtained with the selector switches. The following paragraphs describe the operation of these controls and the accuracy for both the AC-50 and AC-50B.

3-16. AC-50 OUTPUT FREQUENCY ACCURACY. The accuracy of the output frequency is within ±1.0% over the frequency range of 10 to 99,900 Hertz when the VERNIER control is set to the CAL position. Accuracy decreases to about ±3.0% at 0.1 Hertz. Frequency instability is better than 0.02% for one hour at a constant temperature. For applications that require an accuracy which is better than ±1.0%, the VERNIER control can be used to set the exact frequency while monitoring the output with an external frequency counter.

3-17. AC-50B FREQUENCY ACCURACY. When option B, Accurate Frequency, is included in the AC-50 frequency setting accuracy is within ±0.1% over the frequency range of 10 to 9,999 Hertz when the VERNIER control is set to the CAL position. Accuracy of the setting decreases to about ±3.0% at 0.1 Hertz and ±0.3% at 90,000 Hertz. Frequency instability is better than 0.02% for one hour at a constant temperature.

3-18. DECADE FREQUENCY RANGES. Four decade frequency ranges are provided to cover the output frequency range of 0.1 Hertz (0.01 Hertz on AC-50B) to 100 kilohertz. The DECADE range switch selects one of the ranges and positions the decimal point. To achieve the greatest accuracy and resolution the lowest decade range where the desired frequency setting can be obtained should always be used. Table 3-1 and 3-2 show the range of frequency settings for each decade range.

TABLE 3-1. DECADE FREQUENCY RANGES.

FREQUENCY RANGE	SETTING RANGE
100Hz	00.100 to 99.900
1kHz	100.00 to 999.00
10kHz	1000.0 to 9990.0
100kHz	10000. to 99900.

3-19. AC-50 DISCRETE FREQUENCY SETTING. The discrete frequency setting is made with the front panel selector switches which select the three most significant digits of frequency. This provides for

TABLE 3-2. AC-50B DECADE FREQUENCY RANGES.

FREQUENCY RANGE	SETTING RANGE
100Hz	00.010 to 99.990
1kHz	100.00 to 999.90
10kHz	1000.0 to 9999.0
100kHz	10000. to 99990.

three digit resolution over the frequency range of 10 to 99,900 Hertz with resolution decreasing to one digit at 0.1 Hertz. The two least significant digits are fixed at zero so that the displayed front panel setting is always read directly in Hertz and does not require additional interpolation by the operator. Selection of frequencies over 10 Hertz should always be made with the most significant figure of the desired frequency set in the extreme left-hand digit. For frequencies of between 0.1 and 9.9 Hertz, the setting should be made as far to the left as possible. Setting the frequency in this manner will provide the maximum amplitude stability, lowest signal distortion and best resolution. For example, 10 Hertz can be set in the following three ways:

(a) 10.000
(b) 010.00
(c) 0010.0

Example (a) is the correct method and has a resolution of 0.1 Hertz while in (b) the resolution is 1.0 Hertz and in (c) it is 10 Hertz.

3-20. AC-50B DISCRETE FREQUENCY SETTING. With option B (designated AC-50B) a fourth frequency selector switch is provided. This permits the four most significant digits to be set over the frequency range of 10 to 9,999 Hertz. Resolution decreases to one digit at 0.01 Hertz. Only the least significant digit is fixed at zero on the AC-50B. The same procedure for setting the output frequency described above should be followed always setting the most significant digit on the left-hand frequency selector switch.

3-21. VERNIER FREQUENCY CONTROL. The VERNIER frequency control adjusts the output frequency over a narrow range of approximately ±1.5% (±0.15% on AC-50B) from the front panel setting. For most applications the VERNIER control should be left at the CAL setting. At this setting the output frequency is calibrated to the front panel setting and is optimized for the best tracking over the four decade frequency ranges. For applications where an accuracy of better than ±1.0% (±0.1% on AC-50B) is required, the VERNIER control

can be used to set the output frequency with a resolution of approximately 0.006% of setting. To set the VERNIER control with an external counter proceed as follows:

1. Connect a Digital Reciprocal or Frequency Counter to the front panel output terminals. (Note: Some instruments are supplied with an optional rear panel COUNTER OUTPUT connector).

2. Set the DECADE and frequency selector switches to the desired frequency setting.

3. While monitoring the output frequency on the counter, set the VERNIER control for the exact frequency desired.

NOTE

Due to the input impedance non-linearity of most digital frequency counters, the counter must be disconnected after the VERNIER frequency adjustment is made or the output of the AC-50 may be excessively distorted.

3-22. OUTPUT POWER. The AC-50 is rated at an output power of 50VA ±10% over the frequency range of 0.1 to 20,000 Hertz (down -20% at 0.1 Hertz). Maximum open circuit output voltage is 15 volts rms over the frequency range of 50 to 20,000 Hertz.

3-23. OUTPUT TRANSFORMER, OPTION T. When optional feature T (designated AC-50T or AC-50BT) is included the output is transformer coupled providing three output voltage ranges with a maximum open circuit output voltage of 150 volts rms. Output power is 45VA over the midband frequency range of 45 to 20,000 Hertz. Figure 3-1 shows the maximum output voltage as a function of frequency.

3-24. With option T, the output voltage range is set by the rear panel OUTPUT switch which selects one of three precision taps on the output transformer. Selection of the proper range is determined basically by the impedance of the load to be driven. When this impedance is known, the voltage range with a matched load impedance less than this value should be used. Table 3-3 gives the matched load impedance for each range.

3-25. OUTPUT ATTENUATION. The front panel OUTPUT LEVEL controls set the amplitude of the oscillator stage output (i.e., power amplifier stage input). The nominal open circuit output amplitude of the AC-50 (i.e., no load) is 15 volts rms and is set using the STEP and VERNIER controls. The STEP control is an 11 position ladder attenuator which provides coarse attenuation of the output amplitude. The VERNIER control is a divider netowrk which provides a continuously variable amount of attenuation between the coarse steps. For example, setting the STEP attenuator to the 4 position

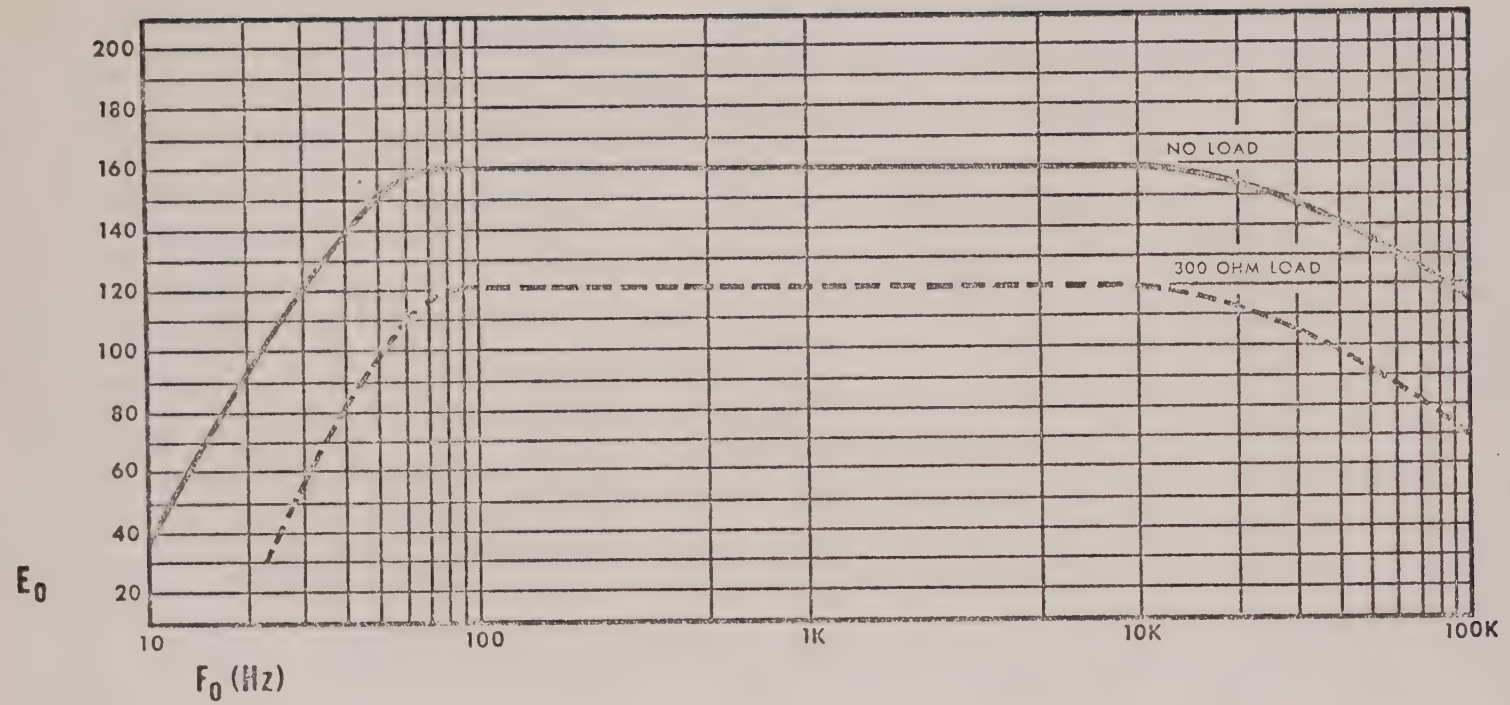

Figure 3-1. Option T Output Voltage.

TABLE 3-3. MATCHED LOAD IMPEDANCES WITH OPTION T.

RANGE	MATCHED LOAD IMPEDANCE	MAXIMUM CURRENT
30V	20 ohms	1.5A
60V	80 ohms	0.75A
120V	320 ohms	0.38A

NOTE

An excessive downward load impedance mismatch should be avoided. Excessive distortion will result if the values listed below are exceeded:

30V Range	10 ohms
60V Range	60 ohms
120V Range	240 ohms

sets the output amplitude range to 4/11ths to 5/11ths of the maximum output. The VERNIER attenuator will then adjust the amplitude over this range, or approximately 5.44 to 6.80 volts rms. Resolution of the VERNIER attenuator setting is approximately 0.1% of setting.

3-26. OUTPUT REGULATION. The apparent internal resistance can be adjusted through zero with the recessed LOAD REGULATION screwdriver adjustment. This adjustment is necessary when driving loads that have an input impedance which varies as a function of the input voltage, such as a Thermal Transfer Standard. It also compensates for the IR drop in the output leads when large currents are being drawn by the load. The load regulation adjustment will remain relatively constant over the midband frequency range with sufficient positive feedback provided in the output amplifier stage to compensate for losses in the load leads over the frequency range of 10 to 40,000 Hertz.

3-27. To set the load regulation use the following procedure:

1. Set the STEP and VERNIER attenuators to zero (fully counterclockwise).

2. Connect an external accurate AC voltmeter at the end of the load leads.

3. Set the frequency and DECADE switches to the desired output frequency.

4. With the load disconnected set the AC-50 to the desired output voltage.

5. Connect the load and adjust the LOAD REGULATION potentiometer until the AC voltmeter reads the same voltage as was set in step 4.

6. Repeat steps 4 and 5 until the voltage does not change from no load to full load. It may be necessary to readjust the output voltage for the no load condition as the LOAD REGULATION adjustment affects the gain of the amplifier.

3-28. When the load is a thermal type of voltmeter or transfer standard, the load impedance will be less at low voltages than at higher voltages. Thus, the lowest voltage to be used will represent the greatest load and the load regulation adjustment should be made at the lowest voltage setting.

3-29. DC BALANCE ADJUSTMENTS. Two DC balance adjustments are provided on the rear panel to set any DC offset of the oscillator and power amplifier stages to zero. These adjustments are not critical and because of the inherently stable characteristics of the instrument it should not be necessary to adjust the DC balance between normal calibration cycles. However, if the load being driven by the AC-50 is sensitive to small DC offset levels or the output transformer, option T, is included these adjustments should be periodically checked. Refer to the calibration section for the DC balance adjustment procedure.

3-30. OUTPUT CONNECTIONS. The output of the AC-50 can be connected for either a floating or grounded configuration. An inner floating chassis completely isolates the instruments electrical grounds from the front panel, exterior covers and AC line ground. In general, when the AC-50 is being used with an instrument that has a permanently grounded low input, such as some digital voltmeters, the output should be connected for a "floating" output. Also, in rack mounted system applications it is desirable to "float" the AC-50 and provide a single ground connection at some other point in the system. When driving an instrument that is floating, such as a battery operated voltmeter, the output should be connected for a grounded output. A ground strap is provided on the front panel low output terminal (black) for grounding the low side of the output to chassis ground. When a floating output is desired the ground shorting link must be removed from the GND terminal. When the rear panel output terminals are being used the front panel shorting strap must be connected for the desired output configuration.

SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. GENERAL. This section contains a description of the circuits and principles of operation for the Model AC-50 Precision AC Calibration Source. The description begins with a general discussion of the overall instrument. A detailed description then follows using simplified block diagrams to show the interconnections between the circuits and their relationship to front panel operating controls.

4-3. SCHEMATICS. A schematic diagram for the Model AC-50 is located at the rear of this manual. Refer to this schematic throughout the following theory discussion for circuit details and electrical values of components.

4-4. AC-50 CIRCUIT DESCRIPTION.

4-5. GENERAL. The AC-50 consists of two separate stages interconnected for operation as a Precision AC Calibration Source. The two basic circuits contained in the instrument are a precision RC oscillator and a precision power amplifier. Interconnection is accomplished internally. Figure 4-1 shows a simplified block diagram of the Model AC-50.

4-6. OSCILLATOR STAGE. The frequency of the RC oscillator stage is selected by three front panel rotary switches and a four position DECADE range switch. Frequency range is 0.1 Hertz to 99,900 Hertz. The output signal is connected to the OUTPUT LEVEL attenuators which set the output amplitude over the range of 0 to 5.0 volts rms maximum. The RC oscillator stage output signal is connected to the input of the power amplifier stage.

4-7. POWER AMPLIFIER STAGE. The power amplifier stage input is DC coupled. Gain of the amplifier is extremely constant and set for approximately 3 to provide an open circuit output voltage of approximately 15 volts rms. A positive feedback circuit in the amplifier permits adjusting the output regulation to essentially zero. The output of the power amplifier is directly coupled to front and rear panel output terminals.

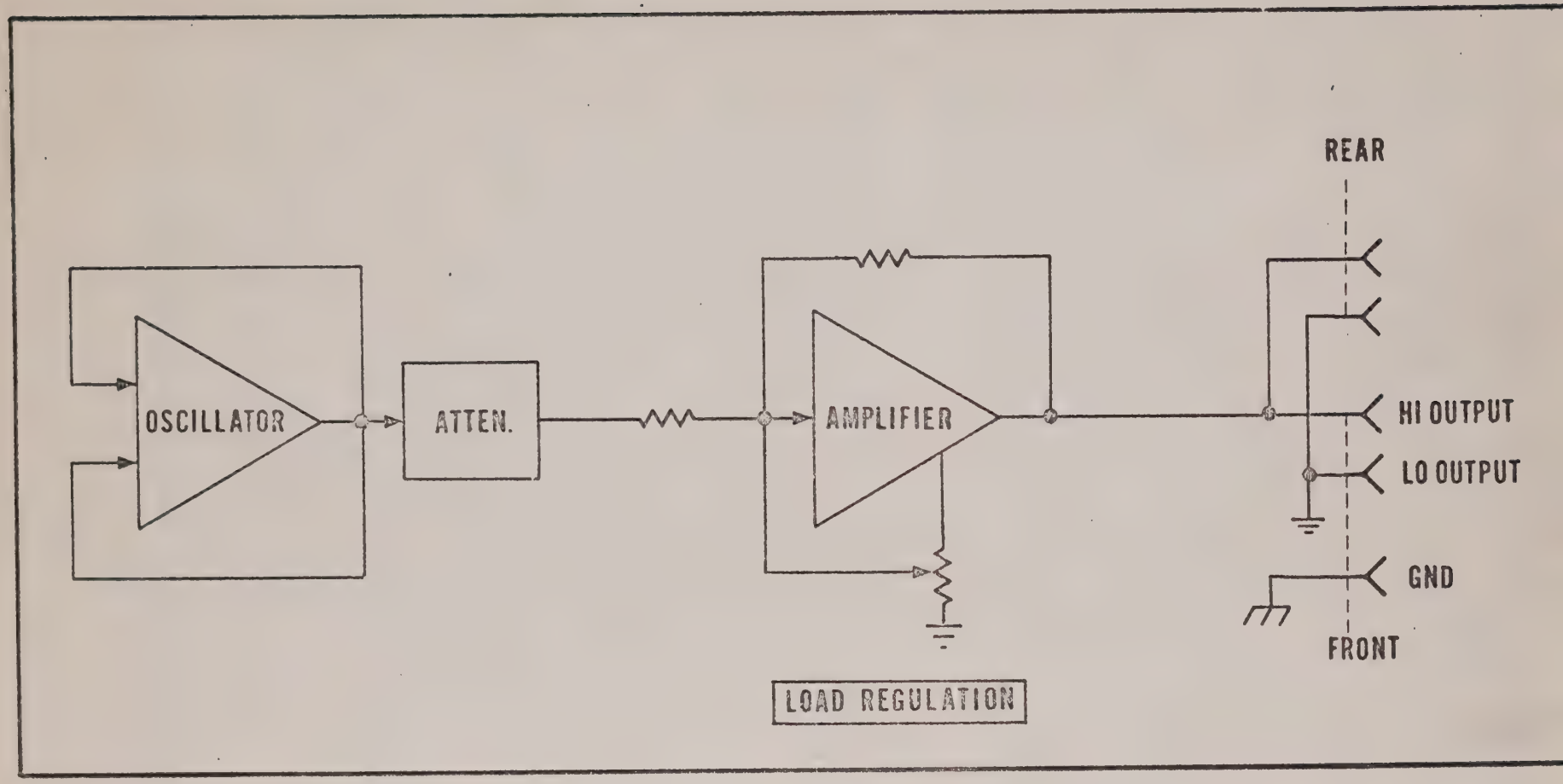

Figure 5-1. AC-50 Block Diagram

4-8. OSCILLATOR CIRCUIT DESCRIPTION.

4-9. GENERAL. The oscillator circuit consists of a Differential Amplifier having a highly stable gain of approximately 30. Negative feedback to the Differential Amplifier is supplied through a bridged-T RC frequency determining network and positive feedback is supplied through a specially designed amplitude stabilizing lamp. The relative magnitude of these two feedback voltages are set so that there is a net excess of positive feedback to provide oscillation at the desired amplitude.

4-10. The Differential Amplifier circuit oscillates at a frequency where the transmission characteristics through the bridged-T network are minimum and phase shift is zero. The FREQUENCY IN CYCLES PER SECOND front panel selector switches select the resistor values and the DECADE switch selects the capacitor values of the bridged-T network to set the output frequency. An Impedance Converter stage reduces the relatively high output impedance of the Differential Amplifier to a low output impedance. The output of the oscillator is then directly coupled through the OUTPUT LEVEL attenuators to the power amplifier stage.

4-11. DIFFERENTIAL AMPLIFIER STAGE. The Differential Amplifier is contained in the dual-triode vacuum tube V1A-V1B. Transistor Q1 is connected to the common cathodes of V1A-V1B and provides a source of constant current. The emitter of Q1 is connected through emitter resistor R12 to -12 volts. The bias on the base of Q1 is set by the divider network R16-R19-R18, connected between the -12 volts and +68 volts power supplies. Since the bias voltage on the base is fixed, the current through Q1 will remain constant. With the sum of the currents drawn by the cathodes of V1A-V1B held constant, a signal applied to the grid of one tube will produce equal and opposite current changes in both V1A and V1B, resulting in differential operation. The plate of V1B is directly connected to the collector of Q2. The emitter of Q2 is connected through emitter resistor R22 to the +68 volts power supply. The base bias of Q2 is set by resistor divider R16-R19-R18 to maintain the current through Q2 constant. Thus, Q2-R22 provide an effective infinit plate load impedance for V1B. The plate of V1A is connected through potentiometer R10 to +68 volts. Connected in this manner, the gain of the Differential Amplifier is approximately equal to the mu of the tube, which is 30 for a 6DJ8. Since mu is determined primarily by the spacing of the elements within the tube, the gain will remain constant over a wide range of external parameters. The grid of V1B is driven by the bridged-T frequency determining network which supplies negative feedback and the grid of V1A is connected to R15-R50-AR1 which supplies positive feedback. Potentiometer R10 is a DC balance adjustment to set the DC offset voltage of the oscillator stage output signal to zero.

4-12. IMPEDANCE CONVERTER STAGE. The output of the Differential Amplifier stage is directly coupled from the plate of V1B to the base

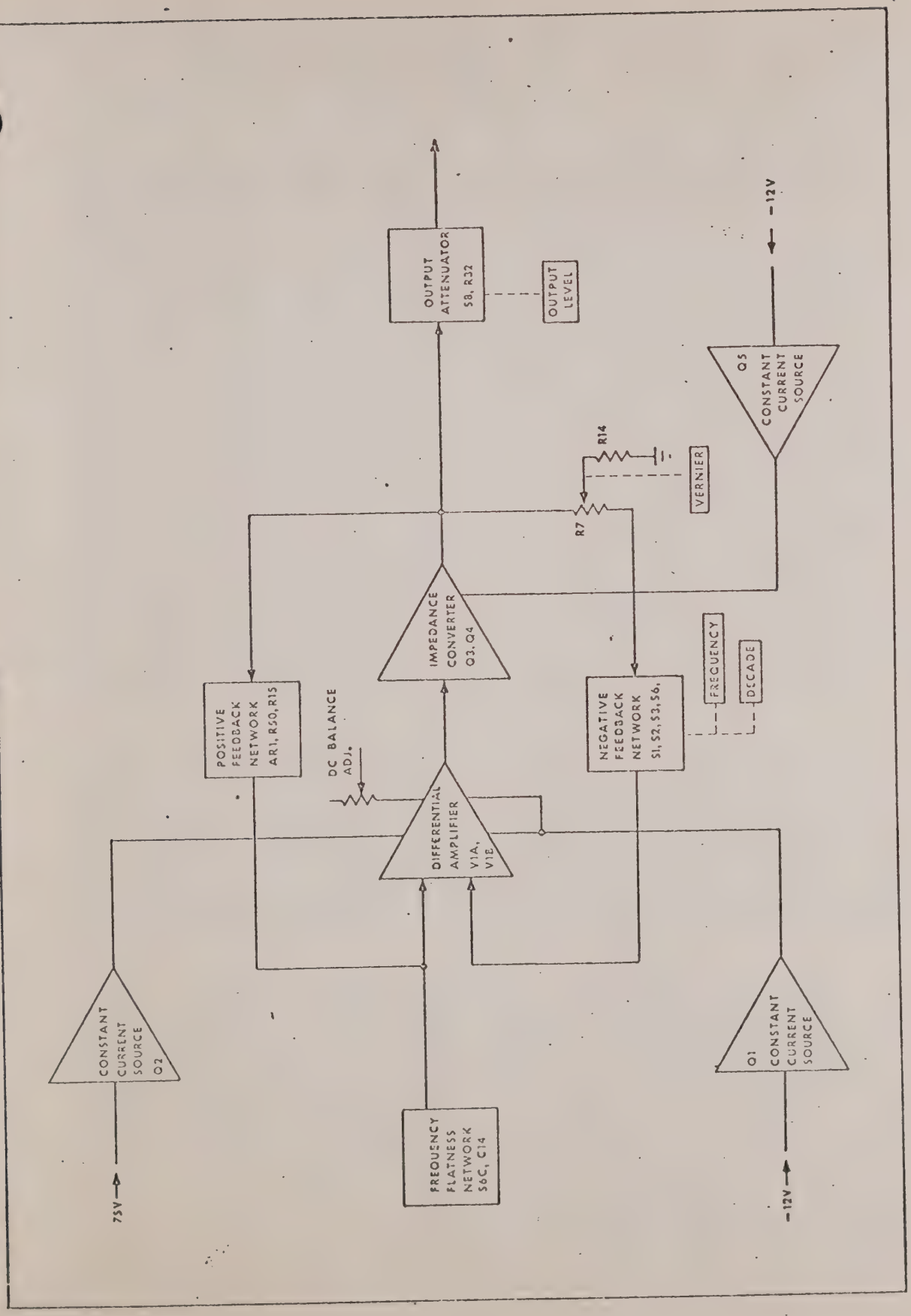

Figure 4-2. Oscillator Circuit Block Diagram.

of Q3. Transistors Q3-Q4 are connected as a cascaded power amplifier stage and convert the high output impedance of the Differential Amplifier to a low output impedance.

4-13. The emitter of Q3 is connected through CR3-C6 to the base of Q4. Zener diode CR3 drops the high DC voltage of about 54 volts present at the plate of V1B to 0 volt eliminating DC offset of the oscillator output signal while maintaining DC coupling between the stages. C6 is a bypass capacitor. R39 is connected between the emitter and base of Q4. Since the signal is essentially the same at both points, the drop across R39 is zero. Thus, effectively the impedance of R39 is infinite and it provides a source of constant current for zener diode CR3. Transistor Q5 is a constant current source for Q4. The bias at the base of Q5 is fixed by resistors R21-R20. The emitter is connected through R25 to -12 volts. Connected in this manner, Q5 forms the emitter resistance for emitter follower Q4 and since the current is held constant the effective emitter impedance of Q4 is infinite to provide a large signal gain. Diode CR18 is connected between the base of Q4 and -6.9 volts which limits the negative voltage swing at the base of Q4 to about -7.2 volts peak. Diode CR17 is connected between the base of Q4 and 8.2 volts to limit the positive voltage swing to about +8.7 volts peak. Zener diode CR4 is connected from +12.4 volts through R45 to ground providing the -8.2 volts for limiting diode CR17. R45 is a current limiting resistor for CR4. This limiting circuit prevents the output amplitude of the oscillator circuit from increasing excessively when changing frequency settings since there is an inherent thermal time lag in amplitude stabilizer AR1. The output signal of the Impedance converter stage is taken directly from the emitter of Q4.

4-14. FEEDBACK NETWORKS. When power is initially applied, approximately one-half of the signal at the emitter of Q4 is applied through the Positive Feedback Network AR1-R50-R15 to the grid of V1A. Approximately one-third of the same signal is connected to the Negative Feedback Network R7-S1-S2-S3-S6-R9 to the grid of V1B. Since the positive feedback is greater than the negative feedback voltage the Differential Amplifier will oscillate at a frequency which is determined by the bridged-T Negative Feedback Network.

4-15. POSITIVE FEEDBACK NETWORK. The stabilizing element AR1 is a lamp which has a mechanically stable tungsten resistive element enclosed within a vacuum. When power is initially applied, the filament of AR1 heats up increasing it's resistance which reduces the amount of positive feedback. The positive feedback stabilizes at a level that is slightly greater than the amount of negative feedback. Since the output amplitude of the Impedance Converter stage in nominally 5 volts rms and the gain of the Differential Amplifier is

approximately 30, the excess positive feedback is about 0.166 volts. If the Oscillator's output amplitude increases, the voltage drop across AR1 will increase which raises it's temperature and increases the resistance. The positive feedback is then reduced and the net signal applied to the Differential Amplifier is lowered, stabilizing the output amplitude. If the amplitude decreases, the voltage drop across AR1 will decrease which will lower it's filament temperature and decrease the resistance. The positive feedback is then increased and the net signal applied to the Differential Amplifier is raised which stabilizes the output amplitude. Potentiometers R17-R46-R51-R52 are connected between the positive feedback input of the Differential Amplifier and ground through S6C and adjust the amount of positive feedback for each decade frequency range to achieve proper amplitude tracking and range to range amplitude flatness.

4-16. BRIDGED-T NEGATIVE FEEDBACK NETWORK. The negative feedback for the Differential Amplifier stage is supplied through the bridged-T Negative Feedback Network which determines the frequency of the Oscillator circuit. The feedback through this network is degenerative, however the bridged-T has a sharp null at one frequency which reduces the degenerative feedback and causes oscillation at this frequency. The ratio of capacitors C1-C2 determine the steepness

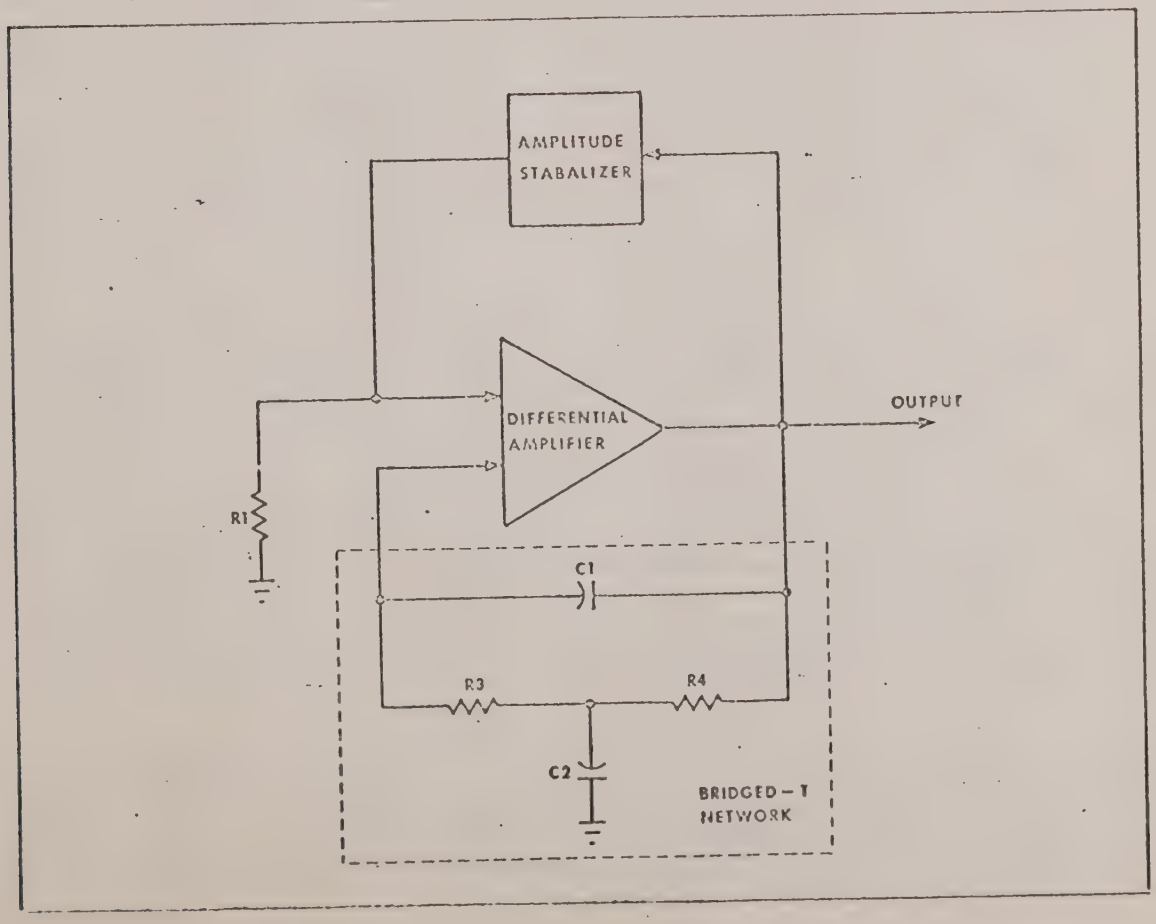

Figure 4-3. Bridged-T Network Equivalent Circuit.

of this transmission slope. Figure 4-3 shows a simplified equivalent circuit for the bridged-T network.

1. The DECADE range switch S6B-S6D selects the appropriate value of capacitors C1-C2 of figure 4-3, which determines the four decade frequency ranges. DECADE range switch S6A connects the corresponding front panel decimal indicator lamps DS1-DS2-DS3-DS4 to -12 volts and the frequency setting is always displayed directly in Hertz. Variable capacitors C1E and C2F calibrate the frequency on the 10 to 100 kilohertz frequency range.

2. The FREQUENCY IN CYCLES PER SECOND switches S1-S2-S3 select the appropriate resistance values of R3-R4 in figure 4-3, which sets the incremental frequency steps of the Oscillator. R3 and R4 of figure 4-3 represent the three digits S1-S2-S3 which are switched resistance decks connected in parallel. The first two significant digits utilize nine resistors in a progressive shorting configuration. The frequency is inversely proportional to resistance and will go up as the selected resistance goes down. For example, two resistors in parallel will provide half the resistance and therefore twice the frequency of oscillation; three in parallel provides one-third the resistance and three times the frequency, etc. The third digit uses a series ladder arrangement of resistors. This series configuration minimizes any unwanted capacitive reactance at the higher resistance values required. In order for the frequency digits to be related by decades, the resistors in the second digit have a value 10 times those used in the first digit, and etc. Specifically, the first digit has nine 31,350 ohm resistors, the second digit has 313,500 ohm resistors. The third digit has appropriate values of resistors in the ladder to maintain this decade relationship. The Differential Amplifier is designed for optimum performance with values of R3-R4 (0f figure 4-3) from approximately 3,000 ohms to 30,000 ohms and the best performance is achieved when the most significant digit of the desired frequency is set in the first or left-hand frequency digit.

3. The VERNIER frequency control R7 varies the amplitude of the Differential Amplifier output signal which is applied to the low-pass section of the bridged-T network while the voltage applied to the high-pass portion is maintained at a constant level. Since the resonant frequency of the bridged-T network is determined by the sum of the transfer functions of the high and low-pass sections in a series manner, the reduction of voltage applied to the low-pass section will increase the frequency of zero phase-shift and cause a corresponding change in frequency. This method of frequency control creates no significant change in transmission through the network. The VERNIER frequency control is a high resolution potentiometer which is used to accurately set the output frequency between the incremental steps of the least significant digit.

4-17. OUTPUT ATTENUATOR. The nominal 5.0 volts rms signal from the Impedance Converter stage is directly connected to the OUTPUT LEVEL controls R34-S8. S8 is an 11 position STEP attenuator which selects progressive steps of the resistive ladder network R30A through R30L. The VERNIER attenuator R34 is a high resolution potentiometer which

interpolates between the coarse steps of the STEP attenuator. The output signal is then directly connected to the Power Amplifier stages.

4-18. POWER AMPLIFIER CIRCUIT DESCRIPTION.

4-19. GENERAL. The Power Amplifier provides amplification of the Oscillator stage signal as set by the OUTPUT LEVEL attenuators. An extremely constant gain of approximately 3 is maintained over the frequency range of the Model AC-50.

4-20. TIME DELAY STAGE. The input signal from the Oscillator stage is coupled to the base of Q103 through K2-R104. K2-K3 form a time delay circuit which opens the input signal path for approximately 45 seconds after power is initially applied. This allows the Oscillator and Power Amplifier circuits to stabilize before applying a signal. When K2 is normally open (i.e., no power applied) the base of input transistor Q103 is grounded through R104 and pins 9 and 8 of K2. When AC power is initially applied the thermal element of time delay relay K3 is connected between +30 volts power supply and ground through the normally open contacts 6 and 7 of K2. After approximately 45 seconds the relay contacts of K3 will close connecting K2 to the +30 volts supply. Contacts 9 and 10 of K2 then complete the input circuit path. Contacts 6 and 7 form a latching circuit for K2 by grounding the coil. Relay K2 will remain latched until power to the instrument is removed.

4-21. INPUT AMPLIFIER STAGE. The Input Amplifier stage Q103-Q104 is connected as an operation amplifier stage. Divider network R104-R105 at the base of Q103 determines the gain of the Power Amplifier. In the AC-50, R104 (series input resistor) is 20 kilohms and R105 (negative feedback resistor) is 75 kilohms, thus the stage gain is approximately 3.8. Since the output amplitude of the Oscillator stage is nominally 5.0 volts rms, the open circuit output amplitude of the Power Amplifier is approximately 19.0 volts rms.

4-22. The input signal is applied to the base of Q103. R106-R135-R151 establish the base bias circuit for Q103. Potentiometer R135 provides an adjustment for setting the DC offset level of the Power Amplifier output to zero. The collector of Q103 is connected to the -30 volts supply and the emitter is connected through R102 to the +69 volts supply forming an emitter follower stage. The signal at the emitter of Q103 is directly coupled to the base of Q104. The collector of Q104 is connected through Q101 to the +69 volts power supply. The base bias of Q101 is held constant by the regulated +60 volts supply and provides a source of constant current for Q104. Connected in this manner Q101 forms the collector load impedance for Q104 and since the current is held constant, effective impedance is infinite providing a large stage gain.

4-23. Positive feedback for the Input Amplifier stage is connected to the base of Q130 through R168-R109. Feedback resistor R110 is connected in series with the center tap of the +30 and -30 volts power supply secondary winding.. As the load current varies a proportional change in the current drawn from the +30 and -30 volts supplies by the output transistors results in a proportional change in the voltage drop across R110. This provides a corresponding proportional change in the positive feedback bias voltage across R109 to compensate for losses in the output stage and external load leads due to the increased loading. Potentiometer R109 provides a front panel adjustment for setting the LOAD REGULATION.

4-24. POWER AMPLIFIER OUTPUT STAGE. The signal is taken from the collector of Q104 and coupled to Q102 through R103-C102. Since the voltage at the collector of Q104 is normally +30 volts the voltage drop across R103 is set for approximatley 28 volts to re-establish a 0 volt offset level at the output of the Power Amplifier. This is accompolished by providing a constant current through R103 which results in a DC voltage drop but no AC signal drop due to the extremely high impedance of the constant current source Q105. The output stage is configured as a standard quasi-complementary-symmetry amplifier. Transistor Q102 is the driver stage with complimentary pair Q115-Q110 providing the necessary phase splitting for push-pull operation of the output driver stages. Q115-Q106-Q107 operate on the positive half-cycles and Q110-Q109-Q108 operate on the negative half cycles. Lamps DS102-DS104 provide current limiting protection for Q102 and Q110. Fuses F2-F3 provide circuit protection for the push-pull stage against excessive overloads due to circuit failures. Pushbutton S8, parallel test points J5-J6 and potentiometer R112 are provided to set the quiescent current of the output transistors for optimum performance.

4-25. OVERLOAD CIRCUIT. Overload protection is provided by Q112-Q113-K1. Q112-Q113 sense the positive and negative output signals developed across sensing resistors R161-R162. A negative going signal is developed across R161 which has a waveshape similar to rectified half cycles of the amplifier stage input signal. The rectified negative cycles are applied to CR127-R146-C125 which forms a peak detector. The resulting negative DC bias voltage stored by C125 is applied across the base-emitter junction of Q112. If this DC voltage exceeds approximately -0.6 volt Q112 will be forward biased and conduct current through relay K1. Transistor Q113 functions in a similar manner, sensing the positive half cycles through sensing resistor R162. Thus, excessive current in either polarity will cause actuation of overload relay K1. When K1 is actuated, diodes CR121-CR122-CR123 are connected in series between the base of Q102 and ground. The voltage drop across CR121-CR122-CR123 is approximately +1.8 volts DC. This slightly positive DC bias voltage applied to the base of Q102 compensates for the base-emitter junction drops of the output transistors which reduces the output voltage at the output to 0 volt. OVERLOAD lamp DS106 is grounded through a second set of contacts in K1 which provides a front panel indication of the overload condition. Also these contacts forward bias Q112 through resistor R164 to latch the overload circuit until

the OVERLOAD button is depressed. When S6 is depressed the bias voltage through R164 is removed and if the overload voltage drop across R161 and R162 has been removed the overload circuit will reset.

4-26. The output of the quasi-complimentary amplifier stage is taken from the emitters of Q106-Q107 and collectors of Q108-Q109 and directly coupled to front and rear panel terminals E1-E2-E3-E4.

SECTION V

CALIBRATION PROCEDURES

5-1. GENERAL.

5-2. Complete calibration instructions for the Model AC-50 and AC-50B are given in this section of the manual. The following procedures will calibrate the instrument to the performance specifications which are given in table 1-1.

5-3. CALIBRATION FREQUENCY.

5-4. The Model AC-50 should be checked and calibrated if necessary every 90 days of operation to insure proper performance when the instrument is being used as a precision AC source.

5-5. TEST EQUIPMENT.

5-6. The test instruments required to complete the calibration procedures are listed below. The specifications given for each instrument are the minimum required and should alternate test instruments be substituted they must meet or exceed these listed specifications.

1. DC MULTIMETER.- Range: 1.0 to 1.5 volts full scale and 150 milliamps full scale. It must provide a high degree of AC isolation. Example: Universal Avometer Model 8.

2. PRECISION AC VOLTMETER.- Accuracy: better than 0.1%; Resolution: 100 microvolts; Range: 0 to 20 volts rms. Example: Fluke Model 931 AC Differential Voltmeter.

3. DIGITAL RECIPROCAL COUNTER.- Accuracy: 1×10^{-5}; Resolution: 6 digits; Frequency range: 10 to 100,000 Hertz. Example: General Radio Type 1159.

4. VARIABLE AUTOTRANSFORMER.- Range: 103 to 127 volts rms; Power: 120VA output. Example: General Radio Type W10MT3W.

5-7. CALIBRATION PROCEDURE.

5-8. GENERAL. The calibration procedure below is arranged in a sequence which allows the Model AC-50 to be calibrated with the minimum interaction of adjustments. If the instruments measured performance is within the limits which are defined in the CHECK step it is recommended that no further adjustments be made. However, if it is desired to obtain the maximum overall performance of the AC-50 then each adjustment should be made to the exact setting even though the measurement falls within the specification limits in the CHECK step.

5-9. TEST SETUP AND WARM UP. The following steps describe the initial setup to be made before proceeding with the calibration procedures.

1. Connect the AC line cord of the instrument to the Autotransformer.

2. Connect the Auto transformer to a 115 volt AC power source and set the POWER switch to ON.

3. Set the AC-50 power switch to ON.

4. Allow the instrument to warm up for 1½ hours at 25°C, ±5°C, prior to making any calibration adjustments or measurements.

5-10. AC-50 CALIBRATION.

5-11. DUST COVER REMOVAL. If any of the following calibration steps determine that internal adjustments are required it will be necessary to remove the dust cover from the instrument as follows:

1. Set the POWER switch to OFF and disconnect the AC power line cord from the rear panel AC LINE receptacle.

2. Place the instrument upside down on a convenient insulated working surface.

3. Remove the bottom cover by removing the flat head screws.

4. Reconnect the AC line cord to the Autotransformer.

5. Set the POWER switch to ON and allow the AC-50 to warm up at least 10 minutes before proceeding with the calibration adjustments.

5-12. DC BALANCE ADJUSTMENTS. The Oscillator circuit DC balance adjustment and Power Amplifier DC balance adjustment are recessed behind the rear panel. They are identified OSC and AMP DC BAL.

1. TEST EQUIPMENT.

a. DC Multimeter.

2. CHECK OSC DC BAL.

a. Set the DECADE and frequency controls for 1000.0 Hertz.

b. Connect the DC Multimeter between the OSC DC BAL test points.

c. The DC Multimeter should read less than ±10 millivolts.

3. CALIBRATE OSC DC BAL.

a. If not, adjust OSC DC BAL (R10) for a reading of exactly 0 volt on the DC Multimeter.

4. CHECK AMP DC BAL.

a. Connect the DC Multimeter between the AMP DC BAL test points.

b. Set the STEP and VERNIER controls to maximum output (fully clockwise).

c. The DC Multimeter should read less than ±100 millivolts.

5. CALIBRATE AMP DC BAL.

a. If not, adjust AMP DC BAL (R135) for a reading of exactly 0 volt on the DC Multimeter.

6. Disconnect the DC Multimeter.

5-13. COLLECTOR CURRENT CALIBRATION. The following steps adjust the quiescent collector current of the output transistors. The adjustments are located on the rear panel and identified BIAS ADJ.

1. TEST EQUIPMENT.

a. DC Multimeter.

2. TEST SETUP.

a. Connect the DC Multimeter between the BIAS ADJ test points located on the rear panel.

b. Set the STEP and VERNIER controls to minimum (fully counter-clockwise).

3. CHECK.

a. With the PRESS TO TEST button depressed the DC Multimeter should read 100 milliamps.

4. CALIBRATION.

a. If not, adjust BIAS ADJ (R112) for 100 milliamps.

5. Disconnect the DC Multimeter.

5-14. OSCILLATOR STAGE AMPLITUDE CALIBRATION. The following steps calibrate the output amplitude of the oscillator stage and amplitude tracking over the decade frequency ranges with the exception of the 100KHz range. The 100KHz decade range is calibrated in conjunction with the frequency calibration procedure.

1. TEST EQUIPMENT.

a. Precision AC Voltmeter.

2. TEST SETUP.

a. Connect the Precision AC Voltmeter to the rear panel OSC DC BAL test points.

b. Set the frequency and DECADE controls for 100.00 Hertz.

3. CHECK 100 HERTZ RANGE.

a. The output amplitude should be between 4.985 and 5.035 volts rms.

4. CALIBRATE 100 HERTZ RANGE.

a. If not, adjust R44 for exactly 5.010 volts rms.

5. CHECK 1kHz RANGE.

a. Set the frequency and DECADE controls for 1000.0 Hertz.

b. The output amplitude should be between 4.985 and 5.035 volts rms.

6. CALIBRATE 1kHz RANGE.

a. If not, adjust potentiometer R47 for exactly 5.010 volts rms.

7. CHECK 90kHz.

a. Set the frequency and DECADE controls for 90000. Hertz.

b. The output amplitude should be between 4.985 and 5.035 volts rms.

c. If not, it will be necessary to perform the calibration adjustments given in paragraph 5-17.

8. CHECK 20 HERTZ.

a. Set the frequency and DECADE controls for 20.000 Hertz.

b. The output amplitude should be between 4.985 and 5.035 volts rms.

9. CALIBRATE 20 HERTZ.

a. If not, adjust potentiometer R17 for exactly 5.01 volts rms.

10. Disconnect the Precision AC Voltmeter.

5-15. OUTPUT FREQUENCY CALIBRATION. The following steps determine if the Model AC-50 is within the output frequency accuracy specifications. For the AC-50B (four digits) use the procedures given in paragraph 5-18. If the instrument meets the CHECK step given below it will NOT be necessary to perform the calibration adjustments given in the following paragraphs.

NOTE

The frequency calibration procedures given in paragraphs 5-15 to 5-17 are for the 3 digit AC-50. For the AC-50B with 4 digits use the calibration procedures starting with paragraph 5-18.

1. TEST EQUIPMENT.

a. Digital Reciprocal Counter.

2. TEST SETUP.

a. Connect the Digital Reciprocal Counter to the front panel output terminals.

3. CHECK.

a. Set the VERNIER control to the CAL position.

b. Set the OUTPUT LEVEL controls to midrange.

c. Set the front panel frequency selector switches and the DECADE switch to the settings given in table 5-1.

d. Record the output frequency readings for each setting.

TABLE 5-1. FREQUENCY TRACKING SETTINGS.

FREQUENCY SETTING	1.0% MEASUREMENT RANGE (HERTZ)	RECORDED READING
10.000	9.900 to 10.100	
100.00	99.00 to 101.00	
1000.0	990.0 to 1010.0	
10000.	9900. to 10100.	
90000.	89100 to 90900.	

e. The decade readings should be within ±1.0% of the front panel settings.

f. If each of the frequency readings are within ±1.0% of each other but are ALL higher or lower than the nominal settings it will be necessary to calibrate the VERNIER frequency control as described in paragraph 5-15.

g. If the 10kHz and 90kHz frequency readings exceed the nominal frequency settings by more than ±1.0%, perform the frequency calibration procedure given in paragraph 5-16.

NOTE

Calibration adjustments are not provided for the lower decade frequency ranges. If the lower ranges do not meet the specification after calibrating the 10 kilohertz range and optimizing the VERNIER control CAL setting it will be necessary to select timing capacitors for the affected decade range or return the instrument to Optimation for calibration.

5-16. VERNIER FREQUENCY CONTROL CALIBRATION. If the measurements performed above determine that ALL of the frequency settings exceeded the specification it will be necessary to calibrate the VERNIER frequency control as follows:

1. TEST EQUIPMENT.

a. Digital Reciprocal Counter.

2. TEST SETUP.

a. Connect the Digital Reciprocal Counter to the front panel output terminals.

3. CALIBRATION.

a. Set the VERNIER frequency control to the position where ALL of the frequency settings are within ±1.0% of the nominal settings (refer to table 5-1).

NOTE

If the VERNIER frequency control cannot be set so that all decade ranges are within ±1.0% of the front panel setting, set the VERNIER control so that the lower three decade ranges are within ±1.0% and proceed with the frequency calibration procedure given in paragraph 5-17.

b. Loosen the two set screws on the VERNIER frequency control knob taking care not to rotate or move the shaft from the optimized setting.

c. When the set screws are loose, rotate the knob until the index mark lines up with the CAL index line on the front panel.

d. Tighten the set screws.

e. Recheck the five frequency settings to verify that the VERN-

IER control knob was not moved during the calibration adjustment and that the readings are still within ±1.0% of the nominal settings with the VERNIER control knob set to the CAL position.

5-17. FREQUENCY CALIBRATION (AC-50). The following steps calibrate the output frequency and amplitude on the 10 kilohertz decade range.

1. TEST EQUIPMENT.

a. Digital Reciprocal Counter.

b. Precision AC Voltmeter.

2. TEST SETUP.

a. Connect the Digital Reciprocal Counter to the front panel output terminals.

b. Connect the Precision AC Voltmeter to the rear panel OSC DC BAL test points.

c. Set the STEP and VERNIER attenuators to midrange.

3. CHECK 10kHz.

a. Set the frequency and DECADE switches to 10000. Hertz with the VERNIER control set to the CAL position.

b. The output frequency reading should be between 9900 and 10,100 Hertz.

c. The output amplitude reading on the Precision AC Voltmeter should be between 4.985 and 5.035 volts rms.

4. CALIBRATE 10kHz.

a. If not, adjust C2F until the output frequency reading is exactly 10,000 Hertz.

b. Recheck the output amplitude. It should be between 4.985 and 5.035 volts rms.

c. If not, adjust C1E to exactly 5.010 volts rms.

d. Repeat steps a, b and c until the most optimum settings for C2F and C1E are obtained for output frequency and amplitude accuracy.

NOTE

Variable capacitor adjustments C2F and C1E are interacting as the output frequency is determined by the ratio of the two capacitor settings.

8. CHECK 90kHz SETTING.

a. Set the frequency selector switches to 90000. Hertz.

b. The output frequency reading should be between 89,100 and 90,900 Hertz.

9. CALIBRATE 90kHz SETTING.

a. If not, adjust C14 to exactly 90,000 Hertz.

10. CHECK 10kHz RANGE TRACKING.

a. Repeat step 3. If the frequency reading at 10,000 Hertz exceeds ±1.0% it will be necessary to recalibrate C2F, C1E and C14 until the amplitude and frequency at 10,000 Hertz and frequency at 90,000 Hertz are within specification.

5-18. AC-50B FREQUENCY CALIBRATION. The following steps determine if the AC-50B (4 digits) is within the frequency accuracy specification. If the instrument meets the CHECK step given below it will NOT be necessary to perform the calibration adjustments given in paragraphs 5-19 and 5-20.

1. TEST EQUIPMENT.

a. Digital Reciprocal Counter.

NOTE

If a Digital Frequency Counter is used in place of the Reciprocal Counter it must be used in the PERIOD mode for frequencies of less than 1 kilohertz to obtain better than 0.1% resolution without using time base settings longer than 10 seconds.

2. TEST SETUP.

a. Connect the Digital Reciprocal Counter to the rear panel DC BAL test points.

3. CHECK.

a. Set the VERNIER control to the CAL position.

b. Set the frequency selector and DECADE switches to the settings given in table 5-2.

c. Record the output frequency reading for each setting.

TABLE 5-2. AC-50B FREQUENCY TRACKING SETTINGS.

FREQUENCY SETTING	0.1% MEASUREMENT RANGE (HERTZ)	RECORDED READING
10.000	9.9900 to 10.101	
100.00	99.900 to 100.10	
1000.0	999.00 to 1001.0	
10000.	9990.0 to 10010.	

d. The decade frequency readings should be within ±0.1% of the decade settings.

e. If each of the frequency readings are within ±0.1% of the decade settings but are ALL higher or lower than the nominal settings it will be necessary to calibrate the VERNIER control as described in paragraph 5-19.

f. If one or more but not all of the frequency readings exceed the nominal settings by more than ±0.1% perform the frequency calibration procedure given in paragraph 5-20.

5-19. VERNIER FREQUENCY CONTROL CALIBRATION (AC-50B). If the measurements performed in paragraph 5-18 determine that ALL of the frequency settings exceeded the specification it will be necessary to calibrate the VERNIER control as follows:

1. TEST EQUIPMENT.

a. Digital Reciprocal Counter.

2. TEST SETUP.

a. Connect the Digital Reciprocal Counter to the rear panel OSC DC BAL test points.

3. CALIBRATION.

a. Set the VERNIER control to the position where ALL of the frequency readings (refer to table 5-2) are within ±0.1% of the nominal settings.

NOTE

If the VERNIER frequency control cannot be set so that all of the DECADE ranges are within ±0.1% of the front panel settings, set the VERNIER control for exactly 1,000 Hertz on the 1kHz range and proceed with the frequency calibration procedure given in paragraph 5-20.

b. Loosen the two set screws on the VERNIER frequency control knob taking care not to rotate or move the shaft from the optimized setting of step a.

c. When the set screws are loose, rotate the knob until the index mark lines up with the CAL index line on the front panel.

d. Tighten the set screws.

e. Recheck the frequency settings to verify that the VERNIER knob was not moved during the calibration adjustment and the readings are still within ±0.1% of the nominal frequency settings with the VERNIER control set to the CAL position.

5-20. FREQUENCY CALIBRATION (AC-50B). The following steps calibrate the output frequency for the four decade ranges.

1. TEST EQUIPMENT.

a. Digital Reciprocal Counter.

b. Precision AC Voltmeter.

2. TEST SETUP.

a. Connect the Digital Reciprocal Counter to the front panel output terminals.

b. Connect the Precision AC Voltmeter to the rear panel OSC DC BAL test points.

c. Set the STEP and VERNIER attenuators to midrange.

d. Set the VERNIER frequency control to the CAL position.

3. CHECK 10Hz.

a. Set the frequency and DECADE range switches to 10.000 Hertz with the "1" set in the extreme left-hand digit and the DECADE switch set to the fully counterclockwise position.

b. The output frequency reading should be between 9.990 and 10.010 Hertz.

4. CALIBRATION.

a. If not, adjust R54 (10Hz on rear panel) until the frequency reading is exactly 10.000 Hertz.

5. CHECK 100Hz.

a. Set the DECADE range switch for 100.00 Hertz.

b. The output frequency reading should be between 99.90 and 100.10 Hertz.

6. CALIBRATION.

a. If not, adjust R55 (100Hz on rear panel) until the frequency reading is exactly 100.00 Hertz.

7. CHECK 1kHz.

a. Set the DECADE range switch for 1000.0 Hertz.

b. The output frequency reading should be between 999.0 and 1001.0 Hertz.

8. CALIBRATION.

a. If not, adjust R56 (1000Hz on rear panel) until the frequency reading is exactly 1000.0 Hertz.

9. CHECK 10kHz.

a. Set the DECADE range switch for 10000. Hertz.

b. The output frequency reading should be between 9,990 and 10,010 Hertz.

10. CALIBRATION.

a. If not adjust C2F until the output frequency reading is

exactly 10,000 Hertz.

b. Check the output amplitude on the Precision AC Voltmeter. It should be between 4.985 and 5.035 volts rms.

c. If not, adjust C1E to exactly 5.010 volts rms.

d. Repeat steps a, b and c until the most optimum settings for both C2F and C1E are obtained for output frequency and amplitude.

NOTE

Variable capacitor adjustments C2F and C1E are interacting as the output frequency is determined by the ratio of the two capacitor settings.

11. CHECK 90kHz SETTING.

a. Set the frequency selector switches to 90000. Hertz.

b. The output frequency reading should be between 89,730 and 90,270 Hertz.

12. CALIBRATION.

a. If not, adjust C14 to exactly 90,000 Hertz.

13. CHECK 10kHz RANGE TRACKING.

a. Repeat step 9. If the frequency reading at 10,000 Hertz exceeds ±0.1% it will be necessary to recalibrate C2F, C1E and C14 until the amplitude and frequency at 10,000 Hertz and frequency at 90,000 Hertz are within specification.

5-21. CHECK POWER AMPLIFIER OUTPUT AMPLITUDE. The following steps check the Power Amplifier stage for correct gain. No adjustments are provided for the Power Amplifier stage.

1. TEST EQUIPMENT.

a. Precision AC Voltmeter.

b. 3 Ohm, 1%, 50 Watt Load Resistor.

2. TEST SETUP.

a. Connect the Precision AC Voltmeter across the front panel output terminals.

b. Set the frequency and DECADE controls to 1000.0 Hertz.

c. Set the OUTPUT LEVEL controls to minimum.

d. Connect the 3 Ohm Load Resistor across the output terminals.

e. Set the OUTPUT LEVEL controls for maximum output.

f. The output amplitude should be greater than 12.25 volts rms.

g. Set the OUTPUT LEVEL controls for minimum output.

3. Disconnect the Load Resistor and Precision AC Voltmeter.

5-22. The above steps complete the calibration of the Model AC-50 and AC-50B Precision Power Oscillators.

SECTION VI

ELECTRICAL PARTS LISTING

6-1. INTRODUCTION.

6-2. This section of the manual contains a complete breakdown and desription of the replaceable parts.

6-3. SELECTED COMPONENTS.

6-4. Electrical parts which are denoted with an asterisk (*) next to the reference designator are selected and matched for their tolerance values by Optimation. When ordering these parts, it is necessary to include both the model number and serial number of the instrument which the part is to be installed. These parts are NOT interchangeable between instruments.

6-5. PARTS ORDERING INFORMATION.

6-6. Replacement parts are available from your local Optimation, Inc. representative or can be obtained from the factory direct. When ordering parts, include the following information:

1. Instrument model number and serial number.
2. Optimation part number of replacement component.
3. Reference designator number.

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
	901240	1st DIGIT SWITCH ASSEMBLY with all components mounted, ready for installation.
R1A*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1B*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1C*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1D*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1E*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1F*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1G*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1H*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R1I*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2A*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2B*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2C*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2D*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2E*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2F*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2G*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2H*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
R2I*	502800	Resistor, Fix MF: 31.35K, 1%, 1/8W
S1	006075	Switch, Rotary: DP 10 position
	901250	2nd DIGIT SWITCH ASSEMBLY with all components mounted, ready for installation.
R3A*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3B*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3C*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3D*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3E*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3F*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3G*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3H*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R3I*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4A*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4B*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4C*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4D*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4E*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4F*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4G*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4H*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W
R4I*	502900	Resistor, Fix MF: 313.5K, 1%, 1/8W

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
S2	006075	Switch, Rotary: DP 10 position
	901260	3rd DIGIT SWITCH ASSEMBLY with all components mounted, ready for installation.
R5A	500380	Resistor, Fix CC: 1.6M, 5%, 1/2W
R5B	502690	Resistor, Fix MF: 523K, 1%, 1/4W
R5C	502600	Resistor, Fix MF: 261K, 1%, 1/8W
R5D	502570	Resistor, Fix MF: 158K, 1%, 1/8W
R5E	502550	Resistor, Fix MF: 102K, 1%, 1/8W
R5F	502510	Resistor, Fix MF: 75K, 1%, 1/8W
R5G	502490	Resistor, Fix MF: 56.2K, 1%, 1/8W
R5H	502450	Resistor, Fix MF: 44.2K, 1%, 1/8W
R5I	502650	Resistor, Fix MF: 348K, 1%, 1/8W
R6A	500380	Resistor, Fix CC: 1.6M, 5%, 1/2W
R6B	502690	Resistor, Fix MF: 523K, 1%, 1/4W
R6C	502600	Resistor, Fix MF: 261K, 1/8W
R6D	502570	Resistor, Fix MF: 158K, 1%, 1/8W
R6E	502550	Resistor, Fix MF: 102K, 1%, 1/8W
R6F	502510	Resistor, Fix MF: 75K, 1%, 1/8W
R6G	502490	Resistor, Fix MF: 56.2K, 1%, 1/8W
R6H	502450	Resistor, Fix MF: 44.2K, 1%, 1/8W
R6I	502650	Resistor, Fix MF: 348K, 1%, 1/8W
S3	006075	Switch, Rotary: DP 10 position
	901290	DECADE SWITCH ASSEMBLY with all components mounted, ready for installation.
C1B*	523061	Capacitor, Fix POS: 0.25mfd, 1%, 50V
C1C*	523041	Capacitor, Fix POS: 0.025mfd, 1%, 50V
C1D*	520301	Capacitor, Fix Mica: 2500pF, 1%, 500V
C1E	520120	Capacitor, Fix Mica: 240pF, 1%, 500V
C1F	532020	Capacitor, Var Cer: 3-12pF, 350V
C2D*	520501	Capacitor, Fix Mica: 0.01mfd, 1%, 500V
C2E*	520230	Capacitor, Fix Mica; 910pF, 1%, 500V
C2F	532040	Capacitor, Var Cer: 4.5-25pF, 350V
R7	513050	Resistor, Var WW: 50 , 20%, 2W
R14	502160	Resistor, Fix MF: 1.15K, 1%, 1/2W
S6	006120	Switch, Rotary: 6P, 5 position

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
	901272	11 POSITION ATTENUATOR ASSEMBLY with all components mounted, ready for installation.
R30A	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30B	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30C	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30D	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30E	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30F	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30G	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30H	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30I	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30J	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30K	502069	Resistor, Fix MF: 249, 1%, 1/8W
R30L	502069	Resistor, Fix MF: 249, 1%, 1/8W
R34	510135	Resistor, Var CC: 500, 20%, 2W
S8	006080	Switch, Rotary: 11 position

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
	901175	OSCILLATOR CIRCUIT BOARD ASSEMBLY with all components mounted, ready for installation.
AR1	901181	Amplitude Stabilizer Assembly
C2B*	523101	Capacitor, Fix POS: 1mfd, 1%, 50V
C2C*	523046	Capacitor, Fix POS: 0.1mfd, 1%, 50V
C3	521010	Capacitor, Fix: 0.005mfd, 10%, 100V
C4	525120	Capacitor, Fix Elect: 100mfd, 15V
C5	522150	Capacitor, Fix Cer: 0.01mfd, 20%, 1000V
C6	522150	Capacitor, Fix Cer: 0.01mfd, 20%, 1000V
C7	523030	Capacitor, Fix POS: 0.001mfd, 5%, 500V
C8	522150	Capacitor, Fix Cer: 0.01mfd, 20%, 1000V
C10	522200	Capacitor, Fix Cer: 0.1mfd, 10%, 100V
C14	531020	Capacitor, Var Air: 2.2-34pF
C28	522200	Capacitor, Fix Cer: 0.1mfd, 10%, 100V
C29	522020	Capacitor, Fix Cer: 3.3pF
C43	522200	Capacitor, Fix Cer: 0.1mfd, 10%, 100V
C44	522200	Capacitor, Fix Cer: 0.1mfd, 10%, 100V
CR3	544310	Diode, Zener: 53.5V, 5%, CD34381
CR4	544030	Diode, Zener: 8.2V, 10%, 1N756A
CR17	543030	Diode: 1N625
CR18	543030	Diode: 1N625
CR24	543030	Diode: 1N625
CR25	543030	Diode: 1N625
Q1	540081	Transistor: 2N3053-1 (selected)
Q2	540114	Transistor: 2N3250-4 (selected)
Q3	540170	Transistor: 2N3707
Q4	540120	Transistor: 2N3512
Q5	540081	Transistor: 2N3053-1 (selected)
R8	502020	Resistor, Fix MF: 49.9, 1%, 1/4W
R9	500030	Resistor, Fix CC: 10, 10%, 1/4W
R12	502100	Resistor, Fix MF: 499, 1%, 1/2W
R15	500030	Resistor, Fix CC: 10, 10%, 1/4W
R16	502190	Resistor, Fix MF: 2K, 1%, 1/2W
R17	511220	Resistor, Var WW: 10K, 1/2W
R18	502150	Resistor, Fix MF: 1.07K, 1%, 1/8W
R19	501040	Resistor, Fix CC: 25K, 1%, 1W
R20	502180	Resistor, Fix MF: 1.5K, 1%, 1/2W
R21	502100	Resistor, Fix MF: 499, 1%, 1/2W
R22	502100	Resistor, Fix MF: 499, 1%, 1/2W
R25	502020	Resistor, Fix MF: 49.9, 1%, 1/4W
R27	502078	Resistor, Fix MF: 324, 1%, 1/8W

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
R28	500110	Resistor, Fix CC: 1K, 10%, 1/4W
R35		Resistor, Fix: Factory selected value
R39	500080	Resistor, Fix CC: 470, 10%, 1/2W
R44	511220	Resistor, Var WW: 10K, 1/2W
R45	500120	Resistor, Fix CC: 1K, 10%, 1/2W
R46	502258	Resistor, Fix MF: 5.1K, 1/2W, 1%
R47	511220	Resistor, Var WW: 10K, 1/2W
R48	502258	Resistor, Fix MF: 5.1K, 2%, 1/2W
R50	502050	Resistor, Fix MF: 257, 1%, 1/8W
R51	507170	Resistor, Fix WW: 226, 1%, 1/2W
R52	507170	Resistor, Fix WW: 226, 1%, 1/2W
R58	502258	Resistor, Fix MF: 5.1K, 2%, 1/2W
R75		Resistor, Fix: Factory selected value
R99	500450	Resistor, Fix CC: 16M, 5%, 1/4W
V1	550020	Tube, Vacuum: 6DJ8

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
	903201	AMPLIFIER BOARD ASSEMBLY with all components mounted, ready for installation.
C100	531010	Capacitor, Var Air: 1.8 to 13pF
C102	522150	Capacitor, Fix Cer: 0.01mfd, 20%, 1000V
C110	522150	Capacitor, Fix Cer: 0.01mfd, 20%, 1000V
C116	525250	Capacitor, Fix Elect: 450mfd, 3V
C124	524019	Capacitor, Fix Tant: 3.9mfd, 10%, 35V
C134	522200	Capacitor, Fix Cer: 0.1mfd, 1%, 100V
CR118	543010	Diode: 1N270
DS102	551125	Lamp: No. 158
DS104	551125	Lamp: No. 158
Q101	540115	Transistor: 2N3250A
Q102	540084	Transistor: 2N3053-4 (selected)
Q103	540091	Transistor: 2N3118-2N4250 Matched Pair
Q104		Part of Q103
Q105	540084	Transistor: 2N3053-4 (selected)
Q110	540192	Transistor: 2N4036-2 (selected)
Q115	540084	Transistor: 2N3053-4 (selected)
Q116	540084	Transistor: 2N3053-4 (selected)
R100	502180	Resistor, Fix MF: 1.5K, 1%, 1/2W
R102	502530	Resistor, Fix MF: 90.9K, 1%, 1/2W
R103	502290	Resistor, Fix MF: 10K, 1%, 1/2W
R104	502540	Resistor, Fix MF: 100K, 1%, 1/2W
R105	502690	Resistor, Fix MF: 523K, 1%, 1/4W
R106A	502660	Resistor, Fix MF: 464K, 1%, 1/2W
R108	500080	Resistor, Fix CC: 470, 10%, 1/2W
R110	507010	Resistor, Fix WW: 0.1, 5%, 2W
R111	502220	Resistor, Fix MF: 3.01K, 1%, 1/2W
R113	502180	Resistor, Fix MF: 1.5K, 1%, 1/2W
R114	500080	Resistor, Fix CC: 470, 10%, 1/2W
R128	500080	Resistor, Fix CC: 470, 10%, 1/2W
R129		Resistor, Fix: Factory selected value
R131	500080	Resistor, Fix CC: 470, 10%, 1/2W
R140		Resistor, Fix: Factory selected value
R150		Resistor, Fix: Factory selected value
R152	502290	Resistor, Fix MF: 10K, 1%, 1/2W
R167	501030	Resistor, Fix MF: 30.1, 1%, 1/2W
R168	502018	Resistor, Fix MF: 39.2, 1%, 1/4W

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
	901510	TIME DELAY RELAY BOARD ASSEMBLY with all components mounted, ready for installation.
K2	015053	Relay, DPDT: 24V R10-E1-22-V700
K3	015080	Relay, Time Delay: SPST 26V 26N045T
	005020	Socket: Noval, PC Mounting
	015100	Socket: Relay, PC Mounting

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
	901216	POWER SUPPLY BOARD ASSEMBLY with all components mounted, ready for installation.
C131	525040	Capacitor, Fix Elect: 10mfd, 50V
C135	525020	Capacitor, Fix Elect: 6mfd, 100V
CR13	543050	Diode: MR1030A
CR14	543050	Diode: MR1030A
CR101	543080	Diode: 1N3254
CR102	543040	Diode, Zener: 1N935
CR105	543040	Diode, Zener: 1N935
CR106	543080	Diode: 1N3254
CR108	543050	Diode: MR1030A
CR109	543050	Diode: MR1030A
CR110	543050	Diode: MR1030A
CR111	543050	Diode: MR1030A
Q7	540140	Transistor: 2N3638
Q12	540082	Transistor: 2N3053-2 (selected)
Q13	540130	Transistor: 2N3567
Q15	540082	Transistor: 2N3053-2 (selected)
Q111	540192	Transistor: 2N4036-2 (selected)
Q116	540082	Transistor: 2N3053-2 (selected)
R40	502180	Resistor, Fix MF: 1.5K, 1%, 1/2W
R41	502191	Resistor, Fix MF: 2K, 1%, 1/8W
R42	507090	Resistor, Fix WW: 17.5, 1%, 5W
R86	500089	Resistor, Fix CC: 680, 5%, 1/2W
R87	502505	Resistor, Fix MF: 68.1K, 1%, 1/2W
R116	502075	Resistor, Fix MF: 301, 1%, 1/2W
R118	507250	Resistor, Fix WW: 18K, 5%, 5W
R119	500120	Resistor, Fix CC: 1K, 10%, 1/2W
R136	500120	Resistor, Fix CC: 1K, 10%, 1/2W
R137	502290	Resistor, Fix MF: 10K, 1%, 1/2W
R148	507110	Resistor, Fix WW: 50, 5%, 5W
R157	500090	Resistor, Fix CC: 750, 5%, 1/2W

REF DESIG	OPTIMATION PART NO.	DESCRIPTION
		AC-15 CHASSIS ASSEMBLY
C13	525801	Capacitor, Elect: 2 X 1,500mfd, 35V
C105	525150	Capacitor, Elect: 150mfd, 150V
C106	525801	Capacitor, Elect: 2 X 1,500mfd, 35V
C107	525801	Capacitor, Elect: 2 X 1,500mfd, 35V
C108	525801	Capacitor, Elect: 2 X 1,500mfd, 35V
C109	525801	Capacitor, Elect: 2 X 1,500mfd, 35V
C113	522200	Capacitor, Fix Cer: 0.1mfd, 100V
C114	522200	Capacitor, Fix Cer: 0.1mfd, 100V
C120	522200	Capacitor, Fix Cer: 0.1mfd, 100V
CR124	543080	Diode: 1N3254
DS1	551115	Lamp, Incandescent: No. 19, 12V
DS2	551115	Lamp, Incandescent: No. 19, 12V
DS3	551115	Lamp, Incandescent: NO. 19, 12V
DS4	551115	Lamp, Incandescent: No. 19, 12V
DS5	551115	Lamp, Incandescent: No. 19, 12V
DS6	551115	Lamp, Incandescent: No. 19, 12V
DS7	551115	Lamp, Incandescent: No. 19, 12V
DS8	551115	Lamp, Incandescent: No. 19, 12V
DS9	551115	Lamp, Incandescent: No. 19, 12V
DS11	551127	Lamp, Incandescent: No. 313, 28V
DS12	551150	Lamp, Incandescent: No. 10C7, 125V
DS101	551140	Lamp, Incandescent: No. TS1195, 12V
DS103	551140	Lamp, Incandescent: No. TS1195, 12V
Q6	540150	Transistor: 2N3715
Q106	540151	Transistor: 2N3715 (selected)
Q107	540082	Transistor: 2N3053-2 (selected)
Q108	540151	Transistor: 2N3715 (selected)
Q109	540082	Transistor: 2N3053-2 (selected)
R10	511190	Resistor, Var WW: 5K, 20%, 2W
R90	500010	Resistor, Fix CC: 1K, 10%, 1/4W
R109	513030	Resistor, Var WW: 10, 5%, 1.5W
R112	511160	Resistor, Var WW: 1K, 20%, 2W
R135	510380	Resistor, Var CC: 500K, 10%, 0.1W
S7	006005	Switch, Toggle: SPDT
S8	006135	Switch, Push: NC SPST
S9	006055	Switch, Slide: DPDT
T1	560040	Transformer, Power

REVISIONS			
SYM	DESCRIPTION	BY	DATE
A	REVISED PER ECO 169 EFFECTIVE 5-11-67	BS	5-11-67
B	REVISED PER ECO 177 EFFECTIVE 6.19.67	HAM	7.25.67
C	REVISED PER ECO 198 EFFECTIVE 11.11.67	HAM	11.28.67
D	REVISED PER ECO 230 EFFECTIVE 7.21.68	AA	11.4.68
E	REVISED PER ECN 349 EFFECTIVE DATE 8/4/70	TAG	8/5/70

VERNIER FREQ
R7 50 CW
R14 1.15K
C19 .8
R100 2K
S6E
R2A THRU R2I †31.35K
R1A THRU R1I † 31.35K
S1A
S1B
R3A THRU R3I 313.5K †
R4A THRU R4I 313.5K †
S2A
S2B
1.58M±5%
R5A THRU R5I
R6A THRU R6I
523K
261K
158K
102K
75K
56.2K
44.2K
348.33K ±.5%
S3A
S3B
S6D
S6C
S6B
S6A
*R35 NOTE 3
R8 49.9
C1B-.25 †
C1C-.025 †
C1D-2500PF †
C1E-240PF
C1F-112PF
AMPLITUDE REGULATOR
AR1
C14 2.2-34PF
R15 10 ±10%
R9-10 ±10%
*R27 324
R17 10K
R46-5.1K
*R50 237
*R51-226
R48-3.4K
R44-10K
*R52-226
R47-10K
R75K 0-10
R76 5TC
H OPT
R89 270K ±10%
J6
SYNC INPUT OPTION G
1N625(2)
CR26
CR24
R99 16W-5%
C43 C44 .1(2)
TO +68.4V
R10 5K DC BAL
C7-.001
R22 499
Q2 2N3250
R18 4.07K
C5 .01
20 6V OPT 'H'
40,75W WITH OPTION H
OSC DC BAL TEST
R90 1K
C10 .1MF 100V
R28 1K ±10%
C29 3.3PF
Q3 2N3707
C6 .01
CR3 53.5 ±5%
VERNIER AMPLITUDE R34 500
R30A THRU R30L 249 OHMS
S8 STEP AMPLITUDE
R88 1K ±10%
J7
COUNTER MONITOR
OPTION J
V1 6DJ8/ ECC88
R19 25K
CR4 8.2V ±5%
CR17 IN625
R45 1K ±10%
Q4 2N3512
R39 470 ±10%
C28 .1
R34 2K
R32 1K
H OPTION
CR18 IN625
Q5 2N3053
R20 1.5K
R25 49.9
R21 499
C8 .01
Q1 2N3053
R12 499
R16 2K
R142 27.4K NOTE 3
C3 .005
10 50V OPT 'H'
-12V
C4 100 15V
R42 17.5
R104 20K
+69V
R128 470 ±10%
Q101 2N3250-4
R100 1.5K
*R102 90.9K
+30V
R103 10K
C102 .01MF
C100 1.8-13PF
Q103 2N4250
Q104 2N3118
C134 .10
Q102 2N3053-4
C113
DS102 #158
R160 100
Q107 2N3053
DS101 #1195
DS106 #19 OVER-LOAD IND.
*R150 10-50
*R129 0-22 ±10%
NOTE 3
Q115 2N3053-4
Q106 2N3715
R108 470 ±10%
C110 .01
0-16V RMS
C120 .10
CR124 †N3254
J1
TEST Ic
R105 12.1K
R106A 1M
R106B 1M
CW
TO -12V
R135 500K
DC BAL ADJ
R131 470 ±10%
Q105 2N3053-4
Q116 2N3053-4
* R140-5-10 ±10%
CR118 IN270
Q110 2N4036-2
S8 PUSH TO TEST
DS103 #195
Q109 2N3053
Q108 2N3715
CR125 IN3254
DS105 #19 OVERLOAD IND.
R111 3.01K
R113 1.5K
CW
R112-1K BIAS ADJ(Ic)
DS104 #158
R114 470 ±10%
R161 100
C114 .1
J3 AMP DC BAL TEST
J4
T2 P/N 560060
C19 3000 25V
R115 50
0-160V
0-80V
0-40V
Z3
Z2
Z1
S10
REAR PANEL
E1
E4
OUTPUT
E2
E5
LINK
E3
J2
R137 10K
R151 200K
R148 50 ±5%
R159 15 K
CW
R110 .10
R109-10
LOAD REGULATION
R87 68K
R136 1K ±10%
Q15 2N3053
Q6 2N3055
CR5 5.1V ±5% LVA51A
Q13 2N3567
R86 680 ±10%
Q7 2N3638
R40 1.5K
R41 2K
C135 6 100V
+68.4V
Q116 2N3053-3
DS12 #10C7
CR101 IN3254
C105 150MF/150V
Q111 2N4036-2
R119 1K
CR106 IN3254
CR107 LVA 51A
R118 18K
DS11 #313
CR102 IN935
CR103 47V±5%
+60V
CR112 IN9648
CR104 30V ±5%
CR105 IN935
C131 10 50V
R157 750
-25V
+25V
C107 (4) 3000 35V
C106
C109
C108
CR108
CR109
CR110
CR111
CR13
CR14
MR1030A (6)
C13 3000 35V
DS5 #19 (5)
DS6
DS7
DS8
DS9
DS1 #19(4)
DS2
DS3
DS4
S9 220 110
BRN
RED
ORG
YEL
GRN/WHT
GRN
GRY
BLK
BLK/WHT
GRN
WHT
J3 AC INPUT 50-400 Hz
F1 1A SB-105-125V .5A SB-210-250V
S7
T1 P/N E560040

CALIBRATION CONTROLS

FREQUENCY:	10KHz	-C1E,C2F
AMPLITUDE:	.1-99.9Hz	-R17
	100-999Hz	-R44
	1KHz-9.99KHz	-R47
	10KHz-99.9KHz	-R47,C1E,C2F

1. ⏚ DENOTES COMMON ELECTRICAL GROUND ON INNER FLOATING CHASSIS.
2. ⏚ DENOTES OUTER CHASSIS AND PANEL GROUND.
3. † SELECTED TOLERANCE.
4. (*) FACTORY SELECTED VALUE.
5. OPTIONAL PART.
6. ALL RESISTORS ±5%.
7. ALL VALUES OF RESISTANCE IN OHMS, ANY CAPACITANCE IN MFDS.

NOTE: UNLESS OTHERWISE SPECIFIED

DASH NO.	QTY	DESCRIPTION	PART OR IDENTIFYING NO.	VENDOR	SPEC. / NO.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ±1/32 DECIMALS XX-.010 XXX-.005 ANGLES ±1°
MAKE FROM DRAWING NO.
MATERIAL
TREATMENT
FINISH

DRAWN K. Stokes 12-14-66
CHECKED
PROJECT ENGINEER
APPROVED
APPROVED
CUSTOMER
FIN. INT.
NEXT ASSY
SPEC. CONTROL NO.
BLADE

OPTIMATION, INC.
north hollywood, calif. tr 7-0953

DRAWING NAME
SCHEMATIC DIAGRAM POWER OSCILLATOR

MODEL AC-15T WITH OPTIONS G & H & J

SIZE D | DRAWING NO. 3124 | REV. E

SHEET 1 OF 1

FORM E NOC 12 66